Module 2
MRP and MRP II

Resources Planning

Introduction

Material Requirement Planning (MRP) is a computerized Planning system developed during 1960s to address the problem of high inventories in manufacturing organizations. Previously, organizations were using the same methodology for controlling all types of inventories. However, MRP system drew attention of managers to the fact that the planning of requirements for production, such as raw materials and work in progress require a different approach from that used for managing finished goods. MRP systems exploit certain unique characteristics of production items. They utilize information on lead time, inventory status, and MPS to ensure availability of items at the time of requirement.

There are broadly two types of inventories in an operations system:

- **1. Operations Inventory**
  This includes all resources (material and capacity) available for the operating system to consume in the production process, e.g. inventory of tyres for an automobile manufacturer.
- **2. Distribution Inventory**
  These are meant for market consumption. E.g. the finished vehicles of automobile manufacturer belong to distribution inventory. The consumption of this depends on the demand in the open market and may be subject to statistical fluctuations. It requires alternative estimation techniques to approximately guess the demand for the day.

We can consider similar examples in the service system as well. Consider a hotel in the Andheri area of Mumbai. The number of rooms to be made available and the number of people to be served lunch or dinner are examples of distribution inventories. In the case of operating inventories, it is a matter of using arithmetic to compute how much inventory to carry, whereas in the case of distribution inventories, the decision is more complex. While it is difficult to decide how many vehicles to assemble on a particular day, it is very easy to compute the exact number of tyres required on that day, once we have decided o the assembly schedule.

Demand Attributes

Operating inventories have independent demand while distribution inventories have independent demand. Hence, planning issues associated with these two types of inventories need to be addressed differently. All other differences stem from this attribute of demand. In the case of dependent demand item, there is no uncertainty. Moreover, the demand manifests at specific points in time, in response to a requirement in the system. Due to certainty, the goal for a planning manager is to make the dependent demand items to exactly match the requirement.

On the other hand, due to uncertainty, independent demand items cannot be made available at a 100% service level. The extra inventory we require increases substantially, as we approach 100% service level in this case. Hence, planning is done for a targeted service level in the case of independent demand items. Since dependent demand items exhibit some structure and have a causal relationship with other items in the system, it is possible to estimate the demand by appropriate planning methodologies. However, in the case of independent demand items, the timing of the order is very crucial, because dependency relationship among items require that items arrive exactly at the required time.

Key differences between dependent demand and independent demand items:

Attribute	Dependent demand	Independent demand
Nature of demand	No uncertainty; dependent; parent–child relationships cause dependency	Considerable uncertainty, independent
Goal	Make resources availability meet requirements exactly	Make availability meet estimated demand for a targeted service level
Service level	100% service level a necessity, feasible to achieve	100% service level not feasible
Demand occurrence	Often lumpy	Often continuous
Estimation of demand	By production planning	By forecasting
How much to order?	Known with certainty	Estimate based on past consumption
When to order?	Very critical, can be estimated	Cannot be answered directly

Planning Framework

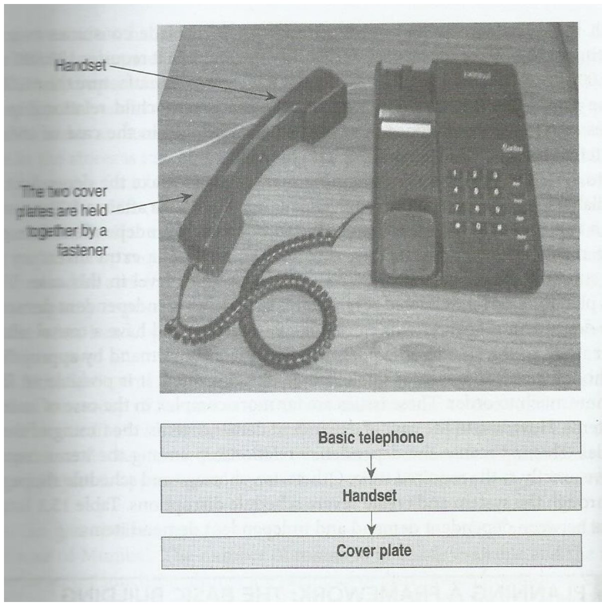
The planning framework consists of following aspects:

- (a) multiple levels of dependency,
- (b) the product structure – the bill of materials (BOM),
- (c) time-phasing the requirement,
- (d) determining the lot size,
- (e) incorporating lead-time information, and
- (f) establishing the planning premises.

In reality, multiple levels of relationships exist in a product. While computing the requirement for an item, it is important that we proceed level by level. Otherwise, the amount of inventory that we make available will be different from what is required.

Product Structure

As it is important to compute the requirement level by level, an unambiguous definition of the levels is crucial. For this, knowledge of product structure is important. In any product, the final assembly stage puts several major assemblies together. Let us consider the example of the basic telephone instrument:



The figures below show the methods of calculating inventory requirement and the product structure of the telephone:

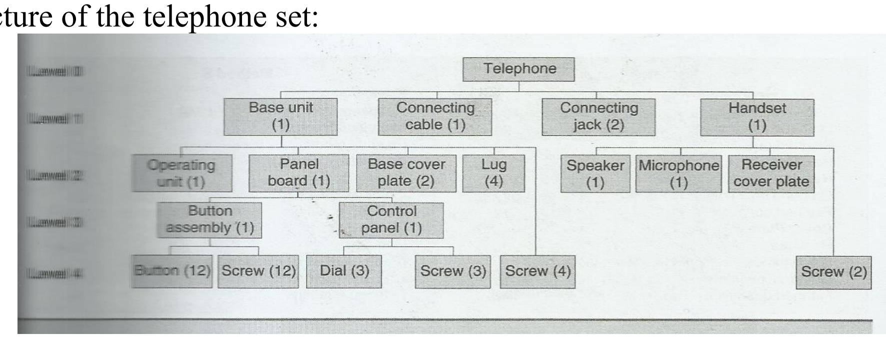
Method A

Basic Telephone	
Required	100
On-hand inventory	30
Planned quantity	70
Handset	
Required	100
On-hand inventory	27
Planned quantity	73
Cover Plate	
Required (Each handset requires two cover plates)	200
On-hand inventory	16
Planned quantity	Manufacturing 184

Method B

	CMR
Basic Telephone	
Required	100
On-hand inventory	30
Planned quantity	70
Handset	
Required	70
On-hand inventory	27
Planned quantity	43
Cover Plate	
Required (Each handset requires two cover plates)	86
On-hand inventory	16
Planned quantity	70

Product structure of the telephone set:



Planning Framework

In this example, two assemblies and two components make up the final product. The base unit assembly, the handset assembly, a connecting cable, and a pair of jacks to connect the ends of the cable with the base unit and the handset, form the product structure. At the next level, we can identify the sub-assemblies that make up each assembly. The base unit assembly consists of the operating unit (consisting of the basic circuitry and processor), the panel board (consisting of buttons to dial the numbers), the control panel (consisting of controls for volume, pulse/tone settings etc.), a pair of cover plates, four lugs (to support the instrument on any surface), and four screws to cover the entire unit using the base plates form the next level. Similarly, we can identify all the components and proceed downwards until we reach the basic raw material/bought out components.

The resulting graphical structure is the product structure, as shown in the figure. When common items appear in more than one level, they must be represented at the lowest level of their appearance. This is known as low level coding. In our example, the item "screw" appears at level 2 and level 4, but we have represented them at level 4. Low level coding does not alter the logic behind planning for the requirement bur merely serves to improve the efficiency of processing. The product structure graphically represents the dependency relationships among various items that make up the final product. Every level in the product structure has a parent relationship with those below it. The numbers in parenthesis show the number of items at a particular level, needed to assemble one unit of its parent.

Bill of Materials (BOM)

In many real life situations, it is not possible to represent the dependency information in the form of a product structure, because the number of components could be numerous and the no: of levels could also be many. In such cases, one can represent this information using a standard data structure, known as the *bill of materials (BOM).* A **bill of materials** is a list of all the parts, or materials required to assemble one unit of a product. A BOM essentially consists of the complete list of each part in the product structure , the components that are directly used in the part, and the quantity of each component needed to make one unit of that part. The data set also includes a short description and the unit of measure for each part. Thus BOM is an alternative representation of a product structure. It provides an efficient methodology to represent complex product structures having multiple levels and numerous items. Codes are used to denote the level at which the item occurs in the product structure, and the number the parent requires to assemble one unit.

A variety of formats are available for BOMs. The simplest format is the *single-level BOM*. It consists of a list of all components that are directly used in a parent item. An *indented BOM* is a form of multi-level BOM. It exhibits the final product as Level 0 and all its components as Level 1. the level numbers increase as you proceed down the tree structure. If an item is used in more than one parent within a given product structure, it appears more than once, under every sub-assembly in which it is used. A third variation is the *modular BOM*. Modular BOMs are very useful to represent product structures with several varieties.

The table below shows a single level BOM for our telephone example:

Table 15.2(a)
A single-level BOM for a telephone instrument

Item code	Item description	UOM	Quantity per product
1000	Basic telephone	Each	1
1010	Base unit assembly	Each	1
1020	Handset assembly	Each	1
1030	Connecting cable	Metre	1
1040	Connecting jack	Each	2
1050	Speaker	Each	1
1060	Microphone	Each	1
1070	Receiver cover plate	Each	2
1080	Panel board assembly	Each	1
1090	Operating unit	Each	1
1100	Lug	Each	4
1110	Base cover plate	Each	2
1120	Button assembly	Each	1
1130	Control panel assembly	Each	1
1140	Buttons	Each	12
1150	Control dials	Each	3
1160	Screw	Each	21

Time Phasing the Requirement

The computing of requirement of items is based on simple arithmetic. Let us consider a two month period as the planning horizon. Let us use the following notations:
Gross requirement for an item during the period: A
Inventory of the item available for the period: B
Net requirement of an item during the period: C.
Since C = A – B, if C is positive, we need to schedule an order for the item so that it arrives at the beginning of the period.
This answers the "how much" question but not "when"

To answer this question, let us return to our telephone example. Based on the planning cycle of the parent, the demand for base cover plates may suddenly crop up during a particular week. If it was decided to produce 100 units of base unit assembly during week 3, 60 units during week 5, and 75 units during week 8, then the gross requirements of base cover plates are 200, 120, and 150, respectively. In between these weeks, there is no need for base cover plates. Let us assume that the on-hand inventory during the period is 350, computed on the basis of what is physically available and what is likely to be available during the two month period.

B: On hand inventory = 350
A: Gross requirement = 470 (200 + 120 + 150)
C: Net requirement = 120.

Therefore, we conclude that we need to place order for 120 base cover plates to meet planned requirements. While this computation is correct, it may not reveal "when" to place the order and if there are any problems that the organization may face by planning in this manner. Let us look at the same data in a different fashion, as shown below:

Time phased estimation of net requirement:

	Period (week)								
	0	1	2	3	4*	5	6	7	8
On hand**	50				300				
Gross requirements				200		120			150
Net requirement				150					120

Notes: *Increase in on-hand inventory by 300 at the end of Week 4 (beginning of Week 5) is due to an order placed earlier; **On-hand data pertains to the inventory at the end of the period.

The table above reveals important information to the planner arising out of the lumpy nature of demand that is characteristic of dependent demand items. Firstly, the on hand inventory due to arrive at the beginning of week 4 (on account of earlier order) is "out of phase" with the requirement. Although the order can cover the requirement for the first five weeks, it is wrongly scheduled. Secondly, it is also clear that our order of 120 needs to arrive at the manufacturing system only at the beginning of week 8. There is no need to order much in advance.

Determining the Lot Size

Lot sizing is the process of determining the size of the order quantities for each component in a product. The lot sizing decision also affects the lead time required for the manufacturing/purchase of components. While deciding on lot size, influence of two sets of costs must be considered. Larger lot sizes will require fewer set-ups (and associated set-up costs), but may result in carrying huge inventory for a longer time. On the other hand, smaller lot sizes require several set-ups, thereby increasing the set-up costs. Balancing these two costs is central to lot sizing decision.

Lot-for-lot (LFL)

This is perhaps the simplest of lot sizing rules. Under this rule, lot size is equal to the net requirement during every period in the planning horizon. If, for a component, the net requirements for the next four weeks are 120, 0, 200, and 50, then the order sizes scheduled to arrive during these four weeks are120, 0, 200, and 50, respectively. The LFL rule is appropriate under following conditions:

- (a) the cost of carrying inventory from one period to the next is very high compared to the cost of set-up.
- (b) the demand for the item is sparse and highly discontinuous

One may find that in situations with complex product configurations and several varieties in the end product, these assumptions hold as we approach the final assembly stage.

The LFL rule for the operating unit of a telephone:

Item: Operating unit	Period (week)								
Lot size rule: Lot for lot	0	1	2	3	4	5	6	7	8
Gross requirements				200		120		130	160
On hand*	50	50	50						
Net requirement				150		120		130	160
Lot size (planned receipt)				150		120		130	160

Note: *On-hand data pertains to the inventory at the end of the period.

Fixed Order Quantity (FOQ)
In this rule, irrespective of the nature of the demand, orders are always placed for a fixed order quantity. Orders are scheduled such that they arrive at the first point of demand. The next order is scheduled to arrive when the first order is insufficient to meet the net requirements for the period. The procedure continues in this fashion until the requirements for the entire period are covered by the orders as shown in the figure below:

Item: Operating unit	Period (week)								
Lot size rule: Fixed order quantity	0	1	2	3	4	5	6	7	8
Gross requirements				200		120		130	160
On hand*	50	50	50						
Net requirement				150		120		130	160
Lot size (planned receipt)				300				300	

Note: *On-hand data pertains to the inventory at the end of the period

In this case, the first point of demand for the operating unit occurs during week 3. Therefore, an order quantity of 300 (FOQ) is scheduled to arrive at the beginning of the week. This quantity satisfies the net requirements until week 6. Therefore, the next order of 300 is scheduled to arrive at the beginning of week 7. Different methods can be used to compute the fixed order quantity (FOQ). One method is to estimate the economic order quantity on the basis of set-up/ordering cost and carrying cost. FOQ provides an alternative perspective to the carrying cost-ordering cost trade-off. In general, when the unit value of the item is low and demand for the item is more or less stable, it is appropriate to use this rule. Items that are at the lower end of a product structure share a greater degree of commonality among numerous end-product variations. Therefore, the demand is likely to be continuous justifying the choice of FOQ rule.

Periodic Order Quantity (POQ)
In this method, an order is placed such that it covers the requirements of P periods. It does not mean that we should place an order quantity during every P period. It only suggests that if we plan an order at a particular time, the quantity should cover the net requirements of P successive periods. The choice of P could be made in alternative ways. One method is to use the review

cycle. If an organization reviews decisions every two months, it could be an appropriate time to also plan the orders. Another method is to use the economic order quantity (Q*) and the average demand during the period to arrive at P. Number of periods P = (Q*) / average demand during planning period

Implementation of POQ rule for operating units with P = 3:

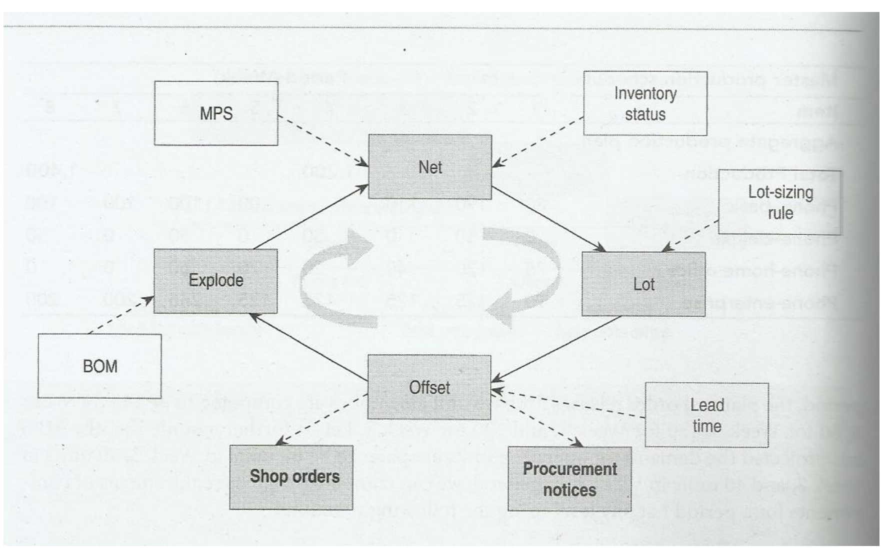
Item: Operating unit	Period (week)								
Lot size rule: Periodic order quantity	0	1	2	3	4	5	6	7	8
Gross requirements				200		120		130	160
On hand*	50	50	50						
Net requirements				150		120		130	160
Lot size (planned receipt)				270				290	

Note: *On-hand data pertains to the inventory at the end of the period

The timing of orders in dependent demand items is very crucial. Errors will have a cascading effect right through the product structure. One important aspect is to incorporate the lead time information in the planning exercise. Accurate computation of component lead times is therefore important in obtaining realistic schedules for the components.

MRP Logic

Material Requirements Planning (MRP) is a structured approach that develops schedules for launching orders for materials in any manufacturing system and ensures availability of these at the right time and at the right place. It uses the basic building blocks of resources planning to develop these schedules. The figure below shows the core logic of MRP process, its input, and output:



As shown in the figure, four key processes drive the MRP procedure. These processes occur in a cyclic fashion. The first process is the "net" process. The MPS for the end product provides information on the gross requirements for the end product. By utilizing the information available in the inventory records, the "net" process computes the net requirements for the end product. The second process is the "lot" process. Once the net requirements are computed, the lot sizing rule is used to schedule planned receipts of the product. The third process is the "offset" process. Once the planned receipts are identified, lead time information is used to offset and obtain planned order releases for the product. The planned order releases are either work orders for a manufacturing shop to assemble as many components as per the schedule or a purchase order to obtain sub-assemblies from outside.

Once these three processes are completed, the requirements for the end product are estimated and orders are scheduled. Then the next step is to cascade the process down the product structure and repeat the procedure with all the components at the next level in the product structure. This process is the last in the cycle denoted as "explode". In order to perform the "explosion" process, BOM data is required. The planned order releases of a parent creates dependent demand for the offspring as specified in the BOM. This becomes the gross requirements for the offspring. The procedure continues iteratively, level by level, until the lowest level is reached and all component schedules are determined.

Therefore, the key inputs for the MRP processes are MPS, BOM, inventory status, lead time data, and lot sizing rule. Each one of these is important in accurately determining the quantity and timing of the material requirements. As we proceed through the lower level of components, two types of outputs are generated from the MRP system. The first output is a work order. work order are generated for items that are manufactured in-house. In our telephone example, we would have generated work orders for base set and handset assemblies as they are likely to be done in-house. The second output is a procurement notice. Procurement notices are generated for items that are bought from outside and directly used in the assembly. It triggers the purchase ordering process. In our telephone example, it is possible that the manufacturer might directly source connecting cables and jacks instead of producing them in-house. The outcome of MRP process is a procurement notice.

Using the MRP System

The most significant impact that a well designed MRP system could provide to an organization is the reduction in inventory. MRP systems were first developed in the early 1960s and organizations that started using them reported dramatic reductions in their inventory. The reasons are obviously related to the logic of exploiting the particular characteristics of dependent demand items. Using traditional EOQ based inventory control system will often result in having inventory when not required. The other advantage is the increased visibility of items and their dependencies through a BOM representation of products being manufactured. Further, it could possibly inculcate a certain discipline in the planning process.

Despite the simplicity and initial success, MRP installations faced several problems after implementation. These were;

The data integrity is low. If the lead time data is wrong, organizations may either have too much inventory or frequent shortages. Similarly, if the inventory status is wrong, it could jeopardize the entire computation. Users did not have the discipline of updating the required databases as and when changes were taking place elsewhere in the organization. If the R & D department creates new design and revisions in existing product design, this data needs to be incorporated in the BOM file. There are uncertainties associated with several issues that lie outside the control of the people and the system. For instance, bad supply management resulting in many uncertainties in lead time and quantity delivered etc. Due to these reasons, the predictions made by MRP systems may often turn out to be less accurate. This could also result in several production schedule changes and consequent delays in the downstream supply chain. Moreover, there are also other limitations in using MRP system. The amount of computation involved in generating component-wise schedules for the planning horizon is large. Real-life examples require thousands of iterations that consume time. Instead of the speed and accuracy increasing continuously, this issue still merits some attention and puts realistic limits to the frequency of generation of MRP schedules.

Therefore, an organization needs to incorporate certain aspects into the MRP planning framework to minimize problems arising out of these issues. Alternative methods are available to re-run an MRP system and they have implications on the accuracy, cost, and time pertaining to the exercise. However, there are methods available to handle some of the uncertainties in the system and thereby reduce the risk of shortage. But such alternatives have cost implications as well.

Updating MRP Schedules

In actual situations, plans become obsolete over time due to several changes in the environment. For example, a customer might have cancelled an order or amended the order quantity and delivery schedule; a supplier could have defaulted in the supply schedule. Similarly, there could have been some unexpected disruptions in the manufacturing and assembly schedules within the manufacturing system. In such cases, the MRP and the schedules for order releases and purchase become inaccurate and call for re-planning. Therefore, the critical to resolve while using the MRP system is the frequency with which the MRP systems are re-run.

We will now discuss certain methods available for updating schedules in MRP:

Regeneration

In this method, the MRP system is run from scratch. Based on the changed information, one can start from level 0 and run the MRP logic right up to the bottom level, amounting to 100% replacement of existing MRP.

Net Change

In this method, instead of running the entire MRP system, schedules of components pertaining to portions where changes have happened are updated. Clearly, net change method of updating MRP schedule modifies only a subset of data as opposed to regeneration. Therefore, it is likely to be computationally more efficient than the regeneration method. Moreover, it may be possible to run it in frequent intervals.

The decision to use net change or regeneration depends on the magnitude of changes that occur in the organization. If the number of changes tend to be large, then it is better to use regenerative method for updating MRP schedules. If the number of changes is small, then it is better to use net change method. The cost of running an MRP system and the number of changes happening in the planning horizon influence the type of updating procedure and the frequency of updation

Safety Stock and Safety Lead Time

Uncertainties in the system that are outside the control of an MRP system is a reality, that organizations need to face and plan for. Generally two types of uncertainties are prevalent:

- Quantity of components received, and
- The timing of receipt.

Poor quality of input material could result in quantity loss on account of rejections. Alternatively, reliability of suppliers may also result in uncertainty in quantity. In the case of components manufactured in-house, there could be uncertainty in supply quantity due to changes in the batch quantity of upstream stages. Therefore, it may be desirable to plan for a safety stock to absorb these uncertainties.

The inclusion of safety stock in MRP computation is fairly straightforward. At the time of "netting" the requirements, an order is scheduled to arrive when the on-hand inventory falls below zero. Instead, the order needs to be scheduled when the on-hand inventory falls below the safety stock. The figure below shows the MRP schedules for a component both without any safety stock and with a safety stock of 50.

MRP schedules without safety stock and with safety stock of 50:

Component XX
BOM quantity 3
Safety stock Nil
Lot size LFL
Lead time 2

	0	1	2	3	4	5	6
Gross requirement		75	75	0	40	90	60
On hand inventory	200	125	50	50	10	0	0
Net requirement		0	0	0	0	80	60
Planned receipts		0	0	0	0	80	60
Planned order releases		0	0	80	60	0	0

Component XX
BOM quantity 3
Safety stock 50
Lot size LFL
Lead time 2

	0	1	2	3	4	5	6
Gross requirement		75	75	0	40	90	60
On hand inventory	200	125	50	50	10	0	0
On hand inventory (net of safety stock)	150	75	0	0	0	0	0
Net requirement		0	0	0	40	90	60
Planned receipts		0	0	0	40	90	60
Planned order releases		0	40	90	60	0	0

The first table shows the MRP schedule where no safety stocks are assumed. We can see that the inventory on hand can satisfy requirements up to period 4. The second table shows that although sufficient inventory is available to meet the requirements of period 4, the on-hand inventory falls below the safety stock of 50. Therefore, 40 units are scheduled to arrive during the beginning of period 4. It is clear that the inclusion of safety stock will result in carrying more inventory throughout the period. Therefore, managers need to exercise careful thought before fixing safety stock levels in an MRP system

Safety lead time while planning for components is quite similar to safety stock. Safety lead time is incorporated in MRP systems by offsetting the planned receipts to the extent of safety lead time. For example, let us assume that the planned receipt for a component during period 5 is 1200 units. If safety lead time is one week, then, by offsetting the planned receipts by one week and scheduling the receipt o period 4, one can ensure that the uncertainties related to time of delivery are largely addressed. Incorporating safety lead time does not inflate the lead time; it merely shifts the planned order release schedule.

The use of safety lead time in MRP is shown in the figure below:

Component XX — BOM quantity: 3 — **Safety lead time:** Nil — **Lot size:** LFL — **Lead time:** 2

	0	1	2	3	4	5	6
Gross requirement		75	75	0	40	90	60
On hand inventory	200	125	50	50	10	0	0
Net requirement		0	0	0	0	80	60
Planned receipts		0	0	0	0	80	60
Planned order releases		0	0	80	60	0	0

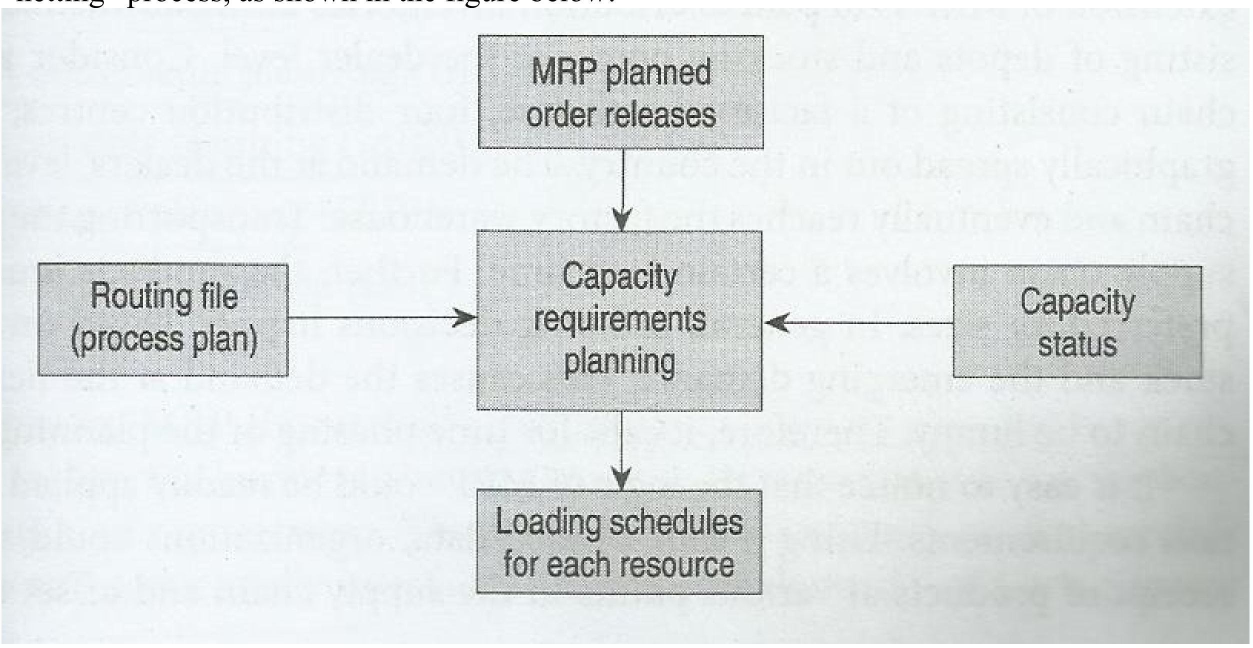
Component XX — BOM quantity: 3 — **Safety lead time:** 1 week — **Lot size:** LFL — **Lead time:** 2

	0	1	2	3	4	5	6
Gross requirement		75	75	0	40	90	60
On hand inventory	200	125	50	50	10	0	0
Net requirement		0	0	0	0	80	60
Planned receipts (before incorporating safety LT)		0	0	0		80	60
Planned receipts (after incorporating safety LT)					80	60	
Planned order releases		0	80	60	0	0	0

Capacity Requirements Planning (CRP)

Capacity requirement planning (CRP) is necessary to ensure that what needs to be produced during a period can in fact be produced. CRP is a technique that applies logic similar to MRP to address the capacity issues in an organization. Similar to MRP, CRP develops schedules for planned releases of capacities to specific work orders as identified in an MRP schedule. The output of an MRP becomes the basis for the CRP exercise. The notion of dependency applies very well to capacities also. Every manufacturing process generates a dependent demand for the resources involved in the conversion process. CRP systems employ the detailed schedule generated by an MRP system as the basis for capacity planning.

Just like MRP system, CRP system also uses the capacity status as the starting point for the "netting" process, as shown in the figure below:



There are similarities between MRP and CRP and therefore organizations use logic similar to that of MRP for performing CRP. However, there are certain important issues that one needs to understand about MRP-CRP-MPS interfaces. In a simple hierarchical mode, MPS will drive MRP and MRP in turn will drive CRP. If both the schedules are feasible, then the plan is finalized. On the other hand, if there are mismatches between capacity and material schedules due to non-availability of capacity to meet the MRP schedule, then it calls for a few iterations of the process. The MRP schedules are first modified to obtain feasible MRP and CRP schedules. However, if this is not possible, then the MPS is modified until feasible schedules are obtained for both material and capacity.

Distribution Requirement Planning (DRP)

The logic of MRP is sufficiently general to apply to several other areas of business. One extension of MRP is to plan distribution inventories in the downstream supply chain, consisting of depots and stocking points at the dealer level. Consider a downstream supply chain consisting of a factory warehouse, four distribution centers, and twenty dealers, geographically spread out in the country. The demand t the dealers' level aggregates up in the chain and eventually reaches the factory warehouse. Transporting the products through supply chain involves a certain lead time. Further, the products are transported in some preferred lot sizes. In general, ordering decisions happen based on a periodic review of stock and the emerging demand. This causes the demand at the next level in the supply chain to be lumpy. Therefore, it calls for time phasing of the planning process.

The logic of MRP can be easily applied to planning distribution requirements. Using time phased data, organizations could schedule the planned receipt of products at various points in the supply chain and offset these by the required lead time to arrive at planned order releases for dispatch of material to the demand points. A dealer may review the inventory on hand and the likely demand during the planning period and arrive at the net quantity to order. Based on lot-sizing considerations, he may lot the order and determine and determine the planned receipts. Further by offsetting the order to the extent of lead time required for receiving the order, he may arrive at the planned order releases for each period. This becomes the gross requirement for the distribution centers. The entire process could be repeated at the distribution centers and the planned order releases of the four distribution centers eventually influence the MPS at the factory.

A DRP exercise will help organizations and their supply chain partners to jointly plan and reduce investment in inventory in the supply chain. They will be able to respond to changes in the demand and have a cost-effective operation. They will also be able to offer high level of service to their customers. However, unlike MRP exercise, DRP exercise relies on key information pertaining to planned order releases outside the domain of the organization. Retailers should be willing to share with dealer the planned order releases and their estimates of upcoming demand, for better planning. Similarly, dealers need to share similar information with the manufacturer. If the information exchange is not proper and there is no data integrity, then the value of the entire exercise will be severely undermined. It will eventually result in inventory build-up or shortages, poor service, and increased costs of operation in the supply chain.

Manufacturing Resources Planning (MRP II)

It was quite logical that newer systems were developed to expand the application of MRP, into other domains of business where dependency relationships exist. In the 1980s, organizations began to incorporate several modules in the MRP systems. This extended version is known as **"Manufacturing Resources Planning (MRP II).** A typical MRP II system consists of following modules:

- Business planning
- Purchasing
- Forecasting / demand management
- Inventory control
- Order entry and management
- – Shop floor control
- – Master production scheduling (MPS)
- – Distribution requirements planning (DRP)
- – Material requirements planning (MRP)
- – Service requirements planning (SRP)
- – Capacity requirements planning (CRP)

– Accounting

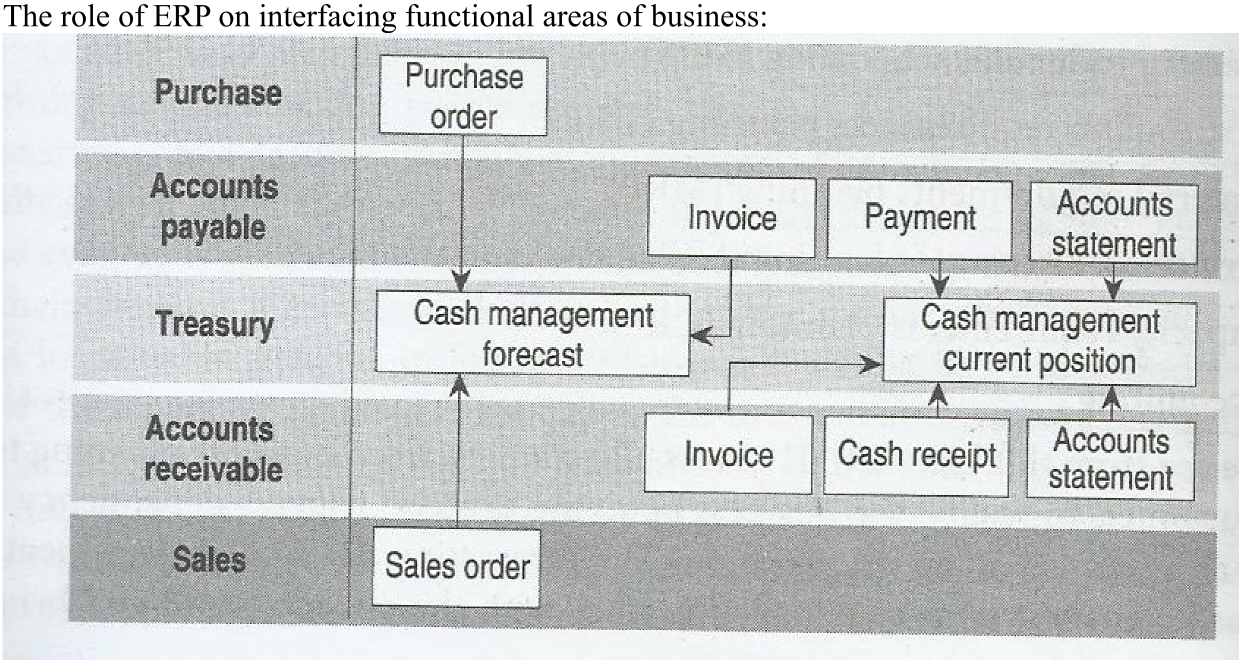
Thus, MRP II covers all activities from business planning to servicing the customer. In reality, business planning exercise triggers dependency relationships for all resources in an organization. The forecasting/demand management module and the order entry system essentially interface with the outside world and bring recent information into the planning system.

Based on these, production planning, MPS and other requirements planning can be done. Since the outcome of these exercises is to procure all items and services from outside and perform the in-house activities as per plan, the relevant modules are also included to close the gap. Essentially, the focus is on planning for all the resources that an operations system requires. The advantage of MRP II lies in the ability to provide numerous feedback loops between different modules and minimize re-planning on a piece-meal basis. As more and more gaps are closed, it promotes a centralized approach to planning and promises to bring additional benefits arising out of integration.

Enterprise Resource Planning (ERP)

ERP is an organization-wide planning system that utilizes some common software and an integrated database for planning and control purposes. ERP embeds all the organization processes into the software and creates a work flow mechanism such that different organizational players engaged in planning and control of a variety of activities can make use of the system. Viewed alternatively, ERP I a mammoth transaction engine that runs on some common software. Since activities in an organization typically have hundreds of processes comprising of thousands of activities. The software is split into modules representing functional domains. Each module has a set of inputs, processes, and outputs. Further, each module is closely interconnected with several other modules. The power of ERP software lies in its ability to manage these interfaces well, thereby providing tighter integration.

The role of ERP on interfacing functional areas of business:



The following are the typical modules in ERP software:

- Sales and distribution
- Production planning
- Logistics
- Accounts payable/receivable, treasury
- Operational (shop floor) control
- Purchasing
- Finance and cost control
- Human resources

In addition, other tools are also available for generating web interfaces, coding and program generation routines, data import/export, and a library of best practices from which an organization could choose processes for implementation.

A wide number of software options are available for ERP. The most popular among them include SAP, Oracle, Rameo systems, Peoplesoft, and ID Edwards. The heart of ERP is the organization-wide integration of several activities. This ranges from integration of functions to markets, divisions, plants, products, and customers across the globe. The greatest benefit to the organization from implementing ERP is its ability to link various functional areas of business tightly through the software. The ERP software will ensure that with the input new information in each of these modules, all the modules will get automatically updated with this information. ERP promises to cut down cycle time, transaction costs, layers of decision making, and thereby improve responsiveness and flexibility. An ERP system could be the backbone of IT infrastructure for an organization. All these will eventually lead to improving competitiveness of the organization at the market place.